Great Bay

YSI Sites
- ▲ Within NERR
- ▲ Not Within NERR

∧ Rivers

■ NS&T Mussel Watch

NERR Management Zone
- Core

Land Use Group
- Agricultural Land
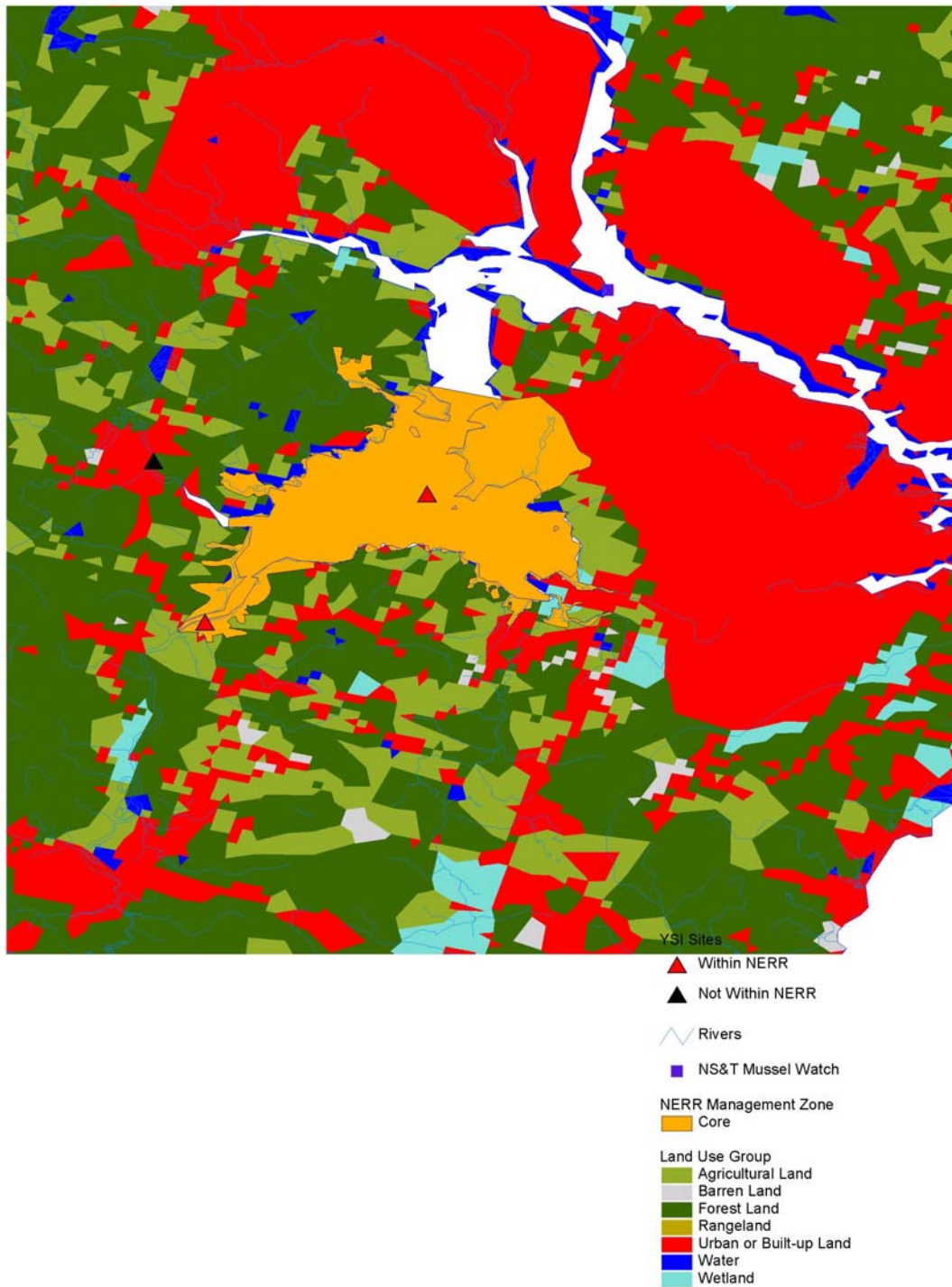- Barren Land
- Forest Land
- Rangeland
- Urban or Built-up Land
- Water
- Wetland

Characterization (Latitude = 43°04′ 20″ N; Longitude = 70°52′ 10″ W)
Tides in Great Bay are semidiurnal and average 2.1 m in range. The Bay has an average depth of 5 m MHW. At the sampling site, the depth is 9.2 m MHW. Creek bottom habitats are primarily mud and rock, without any bottom vegetation. Salt marsh vegetation in Great Bay is predominantly *Spartina alterniflora* (smooth cordgrass) and *S. patens* (salt meadow hay). A variety of other plant species are found in Great Bay marshes, including eelgrass (*Zostera marina*) which occurs (sometimes extensively) throughout the Great Bay Estuary. Annual and perennial salt marsh asters are found in the Reserve's brackish salt marsh areas. The region is characterized as a transition zone between the deciduous forest to the south and the coniferous forest to the north. Common tree species within the area include white pine, red oak, red pine, hemlock, red maple, quaking aspen, and shagbark hickory. This site is relatively un-impacted by anthropogenic disturbances.

Descriptive Statistics
Thirty-eight deployments were made between Apr-Nov in 1996, 1997, and 1998 (Figure 40). Mean deployment duration was 17.1 days. One deployment (Aug 1997) was less than 10 days.
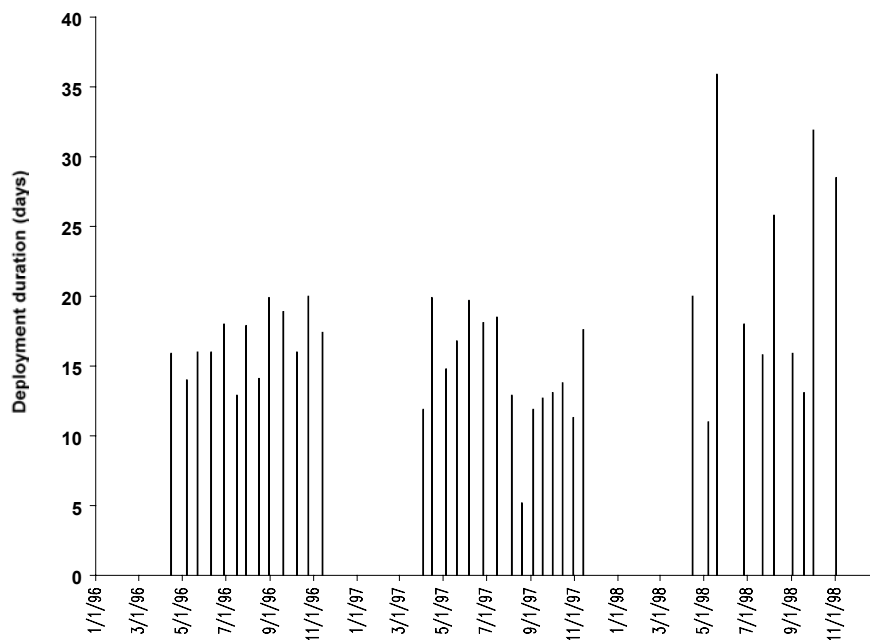

Figure 40. Great Bay Buoy deployments (1996-1998).

Fifty-seven percent of annual depth data in 1996 and 59% of annual depth data in 1997 were included in analyses; no depth data were collected in 1998. The instrument was deployed 1 m below a floating buoy at a mean water depth of 6.5 m MLW so that the depth of the instrument was 5.5-8.2 m above the bottom sediment. Strong fluctuation (2 m) in depth were evident from scatter plots for both daily and bi-weekly intervals; however, amplitude of these fluctuations remained constant across seasons. Harmonic regression analysis attributed 93% of depth variance to 12.42 hour cycles, 3% of variance to 24 hour cycles, and 4% of variance to interaction between 12.42 hour and 24 hour cycles.
Fifty-eight percent of annual water temperature data were included in analyses (58% in 1996 and 1998

and 59% in 1997). Water temperature followed a seasonal cycle; however, annual minimum temperatures were not known because no data were collected between Dec-Mar in all years (Figure 41). Mean water temperature was typically 6-10°C in Apr and Nov and 20-21°C in summer. Minimum and maximum temperatures between Apr-Nov 1996-1998 were 2.2°C (Nov 1997) and 25.3°C (Jul 1997), respectively. Scatter plots suggest moderate fluctuations (1-2°C) in daily water temperature, with stronger fluctuations (3-10°C) in bi-weekly water temperatures, particularly in spring. Harmonic regression analysis attributed 74% of temperature variance to 12.42 hour cycles, 11% of variance to 24 hour cycles, and 15% of variance to interaction between 12.42 hour and 24 hour cycles.
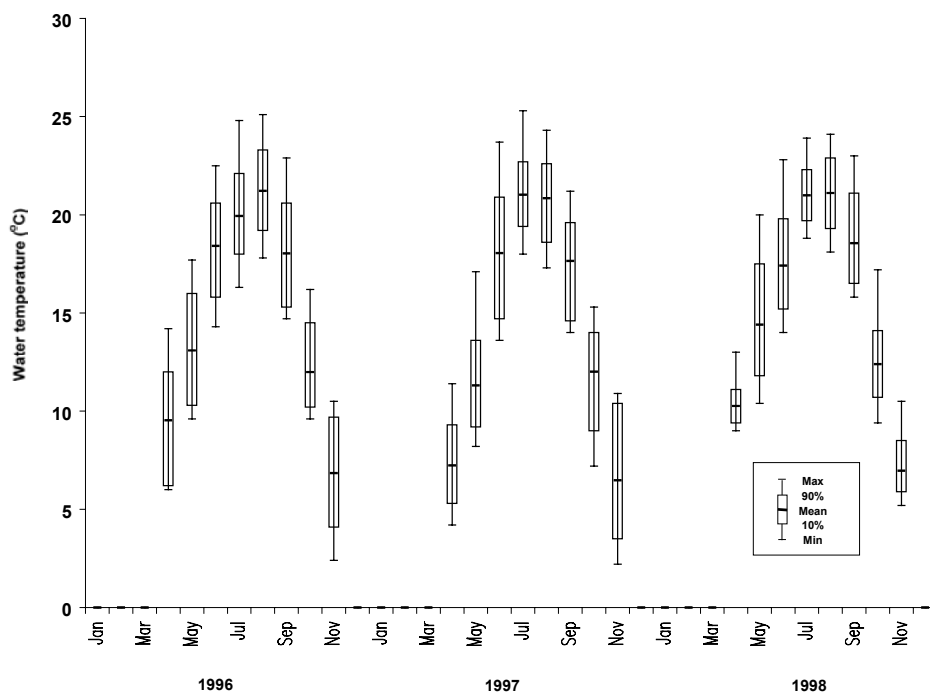

Figure 41. Water temperature statistics for Great Bay Buoy, 1996-1998.

Fifty-eight percent of annual salinity data were included in analyses (58% in 1996 and 1998 and 59% in 1997). Mean salinity followed a seasonal cycle, but large variances were associated with mean salinity in spring and fall (Figure 42). Mean salinity was typically 26-28 ppt in summer and 15-18 ppt in spring and fall. Scatter plots suggest moderate fluctuations (1-3 ppt) in daily and bi-weekly salinity in summer; however, strong salinity fluctuations (≥10 ppt) were observed regularly in spring and fall and during episodic events in summer. Harmonic regression analysis attributed 90% of salinity variance to 12.42 hour cycles, 4% of salinity variance to 24 hour cycles, and 6% of salinity variance to interaction between 12.42 hour and 24 hour cycles.

Fifty-six percent of annual dissolved oxygen (% saturation) data were included in analyses (52% in 1996, 59% in 1997, and 58% in 1998). Mean dissolved oxygen was typically 80-110% saturation; mean DO less than 80% saturation was never observed and mean DO greater than 120% saturation was only observed on one occasion (Jun 1996). Mean DO was slightly less (80-90% sat) in summer than in spring and fall (90-110%); however, large variances were associated with mean DO in the summer. Hypoxia was never observed (Figure 43). Supersaturation was observed in five months and, when present, supersaturation persisted 49% (May 1998), 13-17% (Jul 1996, Sep 1998), and ≤1%

(Apr, Jun 1997) of the first 48 hours post-deployment. Scatter plots suggest daily and bi-weekly fluctuations in percent saturation were typically 20% in spring and fall, but regularly exceeded 40% in summer. Harmonic regression analysis attributed 57% of DO variance to interaction between 12.42 hour and 24 hour cycles, 28% of variance to 24 hour cycles, and 15% of variance to 12.42 hour cycles.
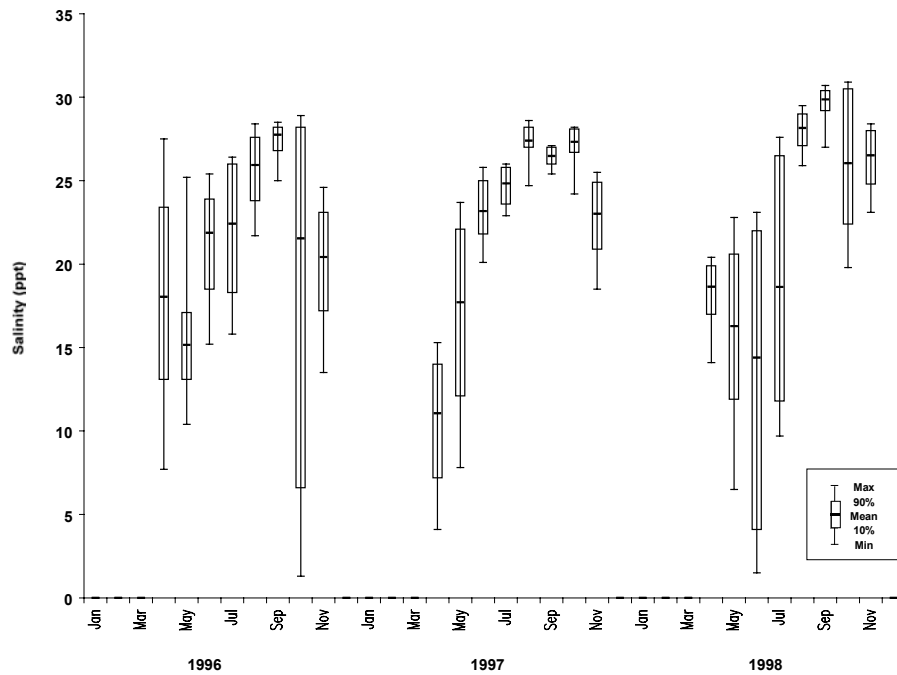

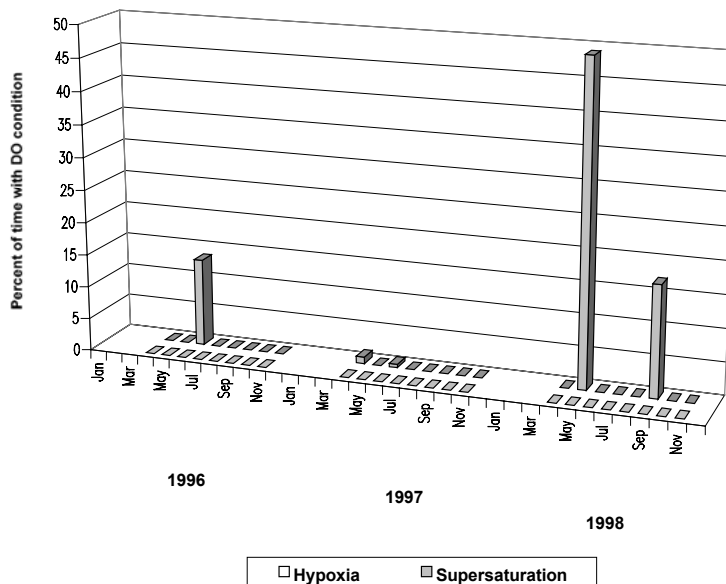**Figure 42**. Salinity statistics for Great Bay Buoy, 1996-1998.

Figure 43. Dissolved oxygen extremes at Great Bay Buoy, 1996-1998.

Photosynthesis/Respiration

Over two thirds (69%) of the data used to calculate the metabolic rates fit the basic assumption of the

method (heterogeneity of water masses moving past the sensor) and were used to estimate net production, gross production, total respiration and net ecosystem metabolism (Table 15). Instrument drift during the duration of the deployments was not a significant problem at this site. Total respiration only slightly exceeded gross production at the Great Bay Buoy; thus, the net ecosystem metabolism and P/R ratio indicated that this is a site where production and respiration are in balance (Figure 44). Temperature was significantly ($p<0.05$) correlated with gross production, total respiration and net ecosystem metabolism. Gross production and respiration increased as temperature increased, while net ecosystem metabolism became more heterotrophic as temperatures increased. Salinity was significantly ($p<0.05$) correlated with gross production, respiration and net ecosystem metabolism. Gross production and respiration were higher at higher salinity, while net ecosystem metabolism became more autotrophic at higher salinity. Thus, the metabolic rates generally followed a seasonal pattern with the lowest rates during the early spring and late fall when temperature and salinity were low and the highest rates during summer months, although summer rates could be highly variable.
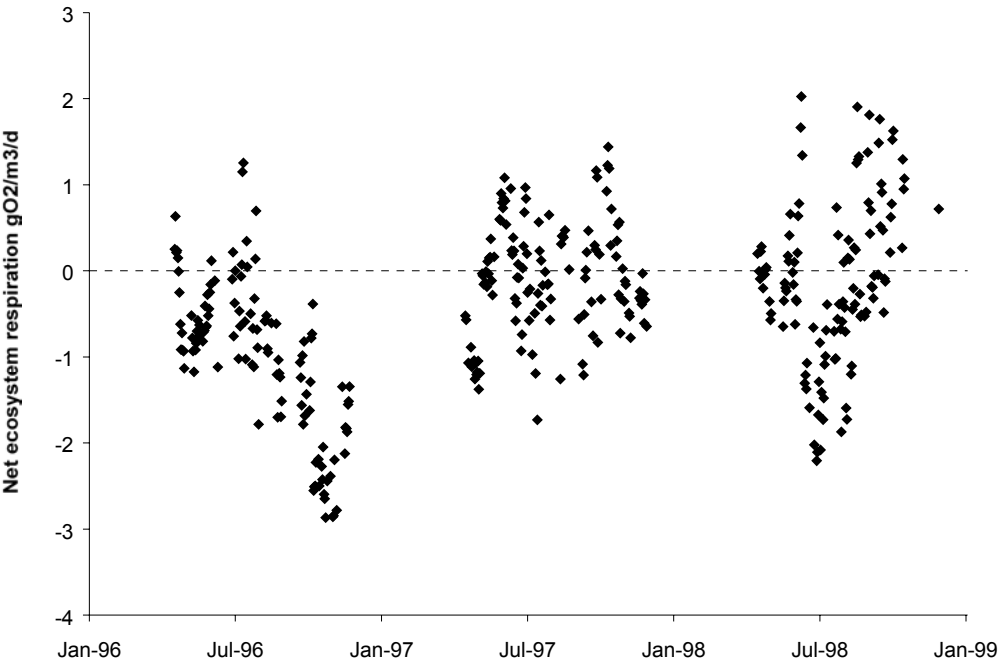

Figure 44. Net metabolism at Great Bay Buoy, 1996-1998.
Table 15. Summary of metabolism data and statistics at Great Bay Buoy, 1996-1998.

Great Bay Buoy	mean	s.e.
Water depth (m)	6.5	
Net production $gO_2/m3/d$	0.41	0.02
Gross production $gO_2/m3/d$	1.05	0.05
Total respiration $gO_2/m3/d$	1.09	0.04
Net ecosystem metabolism g $O_2/m3/d$	-0.04	0.02
Net ecosystem metabolism g C/m2/y	200	
P/R	0.97	
Statistical results		
Drift – paired t-test		
Gross production	ns	
Total respiration	ns	
Net ecosystem metabolism	ns	
Percent useable observations	69%	
Paired t-test on gross production and total respiration	$p < 0.04$	
Correlation coefficient	Temperature	Salinity
Gross production	0.44	0.29
Total respiration	0.49	0.25
Net ecosystem metabolism	-0.06	0.14

Great Bay, Squamscott River (GRBSQ)

Characterization (Latitude = 43°02'30" N; Longitude = 70°55'20" W)
Tides in Squamscott River are semidiurnal with an average range of 2.1 m. At the sampling site, the depth is 6.2 m at maximum high water. Creek bottom habitats are predominantly mud, with no bottom vegetation. The dominant marsh vegetation near the sampling site is *Spartina alterniflora* and *S. patens*. Upland habitats include salt marsh, farmland, and riparian. Activities that potentially impact the site include urban stormwater runoff, two municipal wastewater treatment plants, agriculture, and residential septic systems.

Descriptive Statistics
Eighteen deployments were made at this site between Jul-Nov 1997 and Apr-Nov 1998 (Figure 45). Mean deployment duration was 18.3 days and no deployments were less than 10 days.
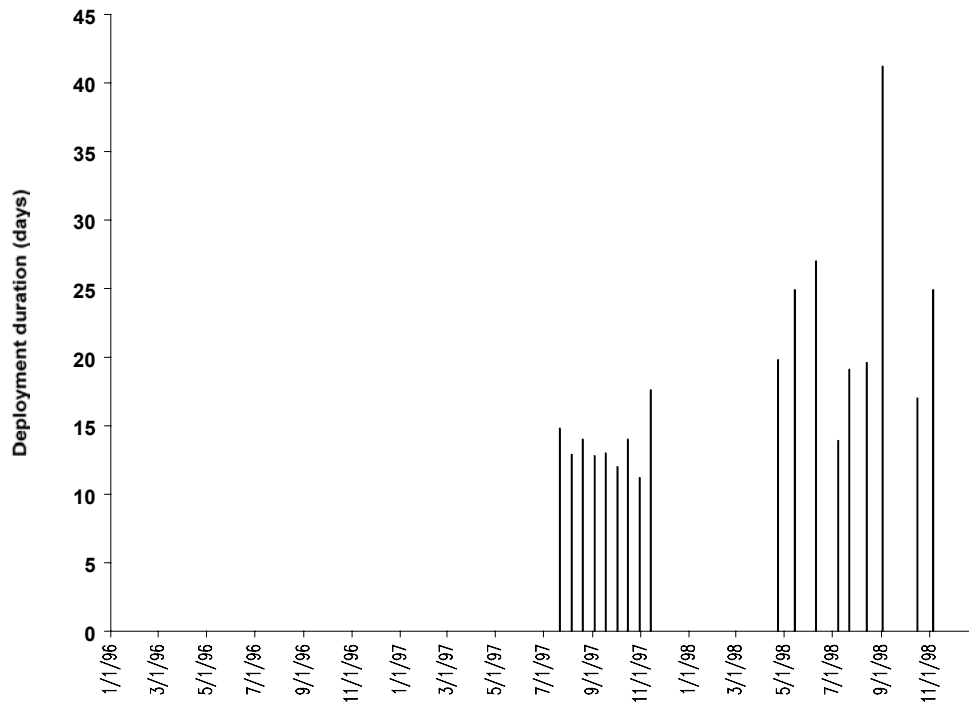
Figure 45. Great Bay, Squamscott River deployments (1996-1998).

Thirty-four percent of annual depth data in 1997 and 48% of annual depth data in 1998 were included in analyses. Sensors were deployed at a mean depth of 3.5 m below the water surface and 0.5 m above the bottom sediment. Strong fluctuations (2-4 m) in depth were evident from scatter plots, with consistent amplitude throughout the data set. Between Jul-Nov 1998, sensors were deployed shallower (0.5-3 m) than during Jul-Nov 1997 and Apr-Jun 1998 (3-6 m). Harmonic regression analysis attributed 93% of depth variance to 12.42 hour cycles, 3% of depth variance to 24 hour cycles, and 4% of depth variance to interaction between 12.42 hour and 24 hour cycles.

Thirty-four percent of annual water temperature data in 1997 and 48% of annual water temperature data in 1998 were included in analyses. Water temperature followed a seasonal cycle; however because no data were collected in winter, true annual minimum temperatures were not known (Figure 46). Mean water temperatures were 22-23°C in summer, 11-12°C in Apr and Oct and 5-6°C in Nov. Minimum and maximum water temperatures were 0.8°C (Nov 1998) and 27°C (Jul 1998), respectively. Scatter plots suggest moderate fluctuations (1-2°C) in daily water temperature, with strong temperature fluctuations (3-10°C) at bi-weekly intervals. Harmonic regression analysis attributed 38% of temperature variance to interaction between 12.42 hour and 24 hour cycles, 29% of temperature variance to 12.42 hour cycles, and 33% of temperature variance to 24 hour cycles.
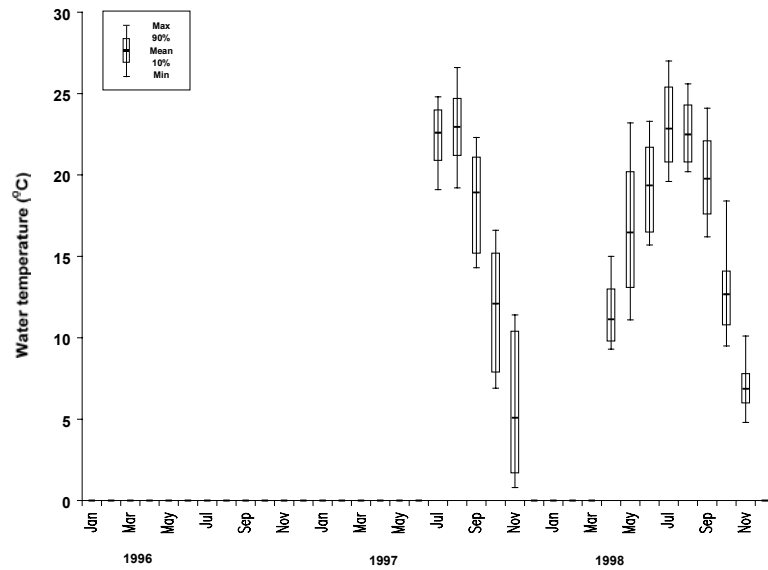
Figure 46. Water temperature statistics for Squamscott River, 1996-1998.

Thirty-four percent of annual salinity data in 1997 and 48% of annual salinity data in 1998 were included in analyses. Salinity followed a seasonal cycle; however, large variances (≥10 ppt) were associated with mean salinity readings throughout most of the data (Figure 3). Mean salinity was greatest (20-26 ppt) in summer/fall and least in spring (4-6 ppt). Mean salinity was higher than usual in fall 1997 and lower than usual in summer 1998. Minimum and maximum salinity observed was 0 ppt (May-Jun 1998) and 29.9 (Aug-Sep 1998), respectively. Scatter plots suggest strong fluctuations (5-10 ppt) in daily and bi-weekly salinity between Jul-Oct 1997 and Aug-Sep 1998. Strongest fluctuations (10-20+ ppt) in daily and bi-weekly salinity occurred in Nov 1997, May-Jul 1998, and Oct-Nov 1998. Harmonic regression analysis attributed 82% of salinity variance to 12.42 hour cycles and 9% of salinity variance each to 24 hour cycles and interaction between 12.42 hour and 24 hour cycles.
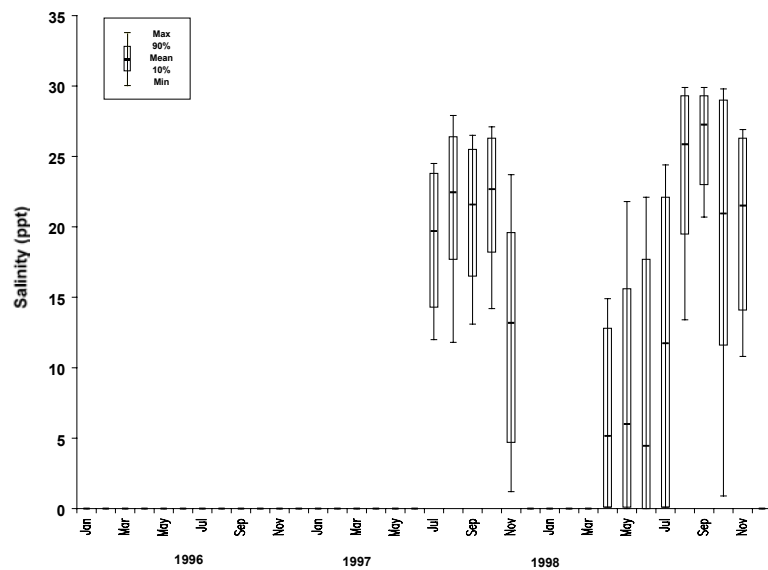

Figure 47. Salinity statistics for Squamscott River, 1996-1998.

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Thirty-four percent of annual dissolved oxygen (% saturation) data in 1997 and 41% of annual dissolved oxygen data in 1998 were included in analyses. Mean dissolved oxygen ranged from 88-101% saturation. Minimum and maximum percent saturation was 45.2% (Aug 1997) and 147.3% (Oct 1997), respectively. Hypoxia was never observed (Figure 48). Supersaturation was only observed in two months (Oct 1997, Jun 1998) and, when present, supersaturation persisted for less than 4% of the first 48 hours post-deployment on average. Scatter plots suggest that percent saturation fluctuated by 20-60% over daily and bi-weekly intervals. Harmonic regression analysis attributed 59% of DO variance to 12.42 hour cycles, 22% of DO variance to 24 hour cycles, and 19% of DO variance to interaction between 12.42 hour and 24 hour cycles.
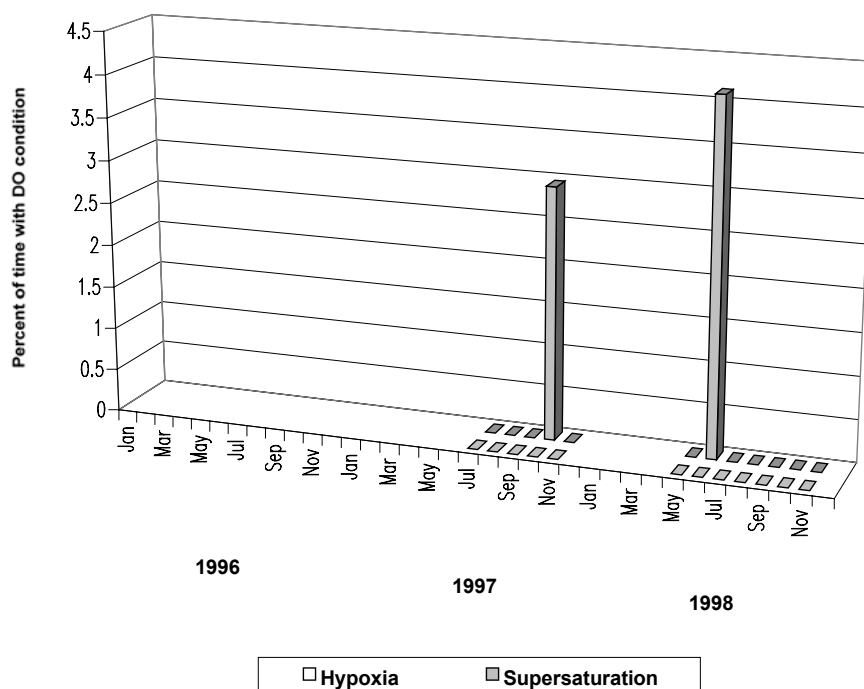

Figure 48. Dissolved oxygen extremes at Squamscott River, 1996-1998.

Photosynthesis/Respiration

Over three quarters (80%) of the data used to calculate the metabolic rates fit the basic assumption of the method (heterogeneity of water masses moving past the sensor) and was used to estimate net production, gross production, total respiration and net ecosystem metabolism (Table 16). Instrument drift during the duration of the deployments was not a significant problem at this site. Total respiration exceeded gross production at Squamscott River; thus, the net ecosystem metabolism and P/R ratio indicated that this is a heterotrophic site (Figure 49). Temperature was significantly ($p<0.05$) correlated with gross production and total respiration, but not net ecosystem metabolism. Gross production and respiration increased as temperature increased. Salinity was not significantly ($p<0.05$) correlated with any metabolic measurement.

Table 16. Summary of metabolism data and statistics at Squamscott River, 1996-1998.

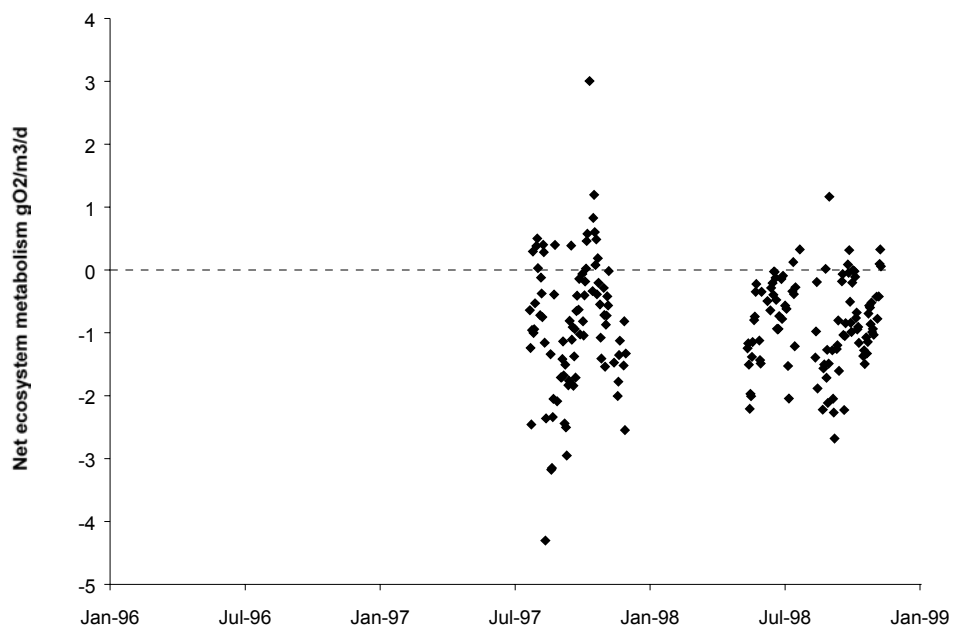| Squamscott River	mean	s.e.
Water depth (m)	3.5	
Net production gO$_2$/m3/d	0.48	0.04
Gross production gO$_2$/m3/d	1.46	0.10
Total respiration gO$_2$/m3/d	1.72	0.11
Net ecosystem metabolism g O$_2$/m3/d	-0.27	0.03
Net ecosystem metabolism g C/m2/y	55	
P/R	0.85	
Statistical results		
Drift – paired t-test		
Gross production	ns	
Total respiration	ns	
Net ecosystem metabolism	ns	
Percent useable observations	80	
Paired t-test on gross production and total respiration	$p < 0.001$	
Correlation coefficient	Temperature	Salinity
Gross production	0.39	ns
Total respiration	0.40	ns
Net ecosystem metabolism	ns	ns

Figure 49. Net metabolism at Squamscott River, 1996-1998.